

Bile duct injuries during laparoscopic cholecystectomy

Lesões das vias biliares no decurso de colecistectomias laparoscópicas

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ABSTRACT

Introduction: Most studies on the subject have shown that bile duct injury (BDI) occurs more commonly in laparoscopic cholecystectomy than in the open procedure. Even though there is a certain awareness of this problem, more attention should be paid to early recognition and prevention of BDI. **Methods:** A review of English language literature from the last 15 years on the occurrence, management and prevention of bile duct injury was performed. Older benchmark articles on the subject were also included. Data resources: PubMed and Scopus database research. **Results:** Approximately 1500 articles came as a result of searching the keywords “bile duct injuries” and “laparoscopic cholecystectomy”. A selection of 68 articles was made based on the abstract, directed according to the subject of interest for the discussion of this review and 49 were included on the bibliography, for being considered of most interest. **Conclusions:** Bile duct injury could be avoided by proper and precise anatomical identification and careful dissection. Intraoperative cholangiography helps in decreasing incidence and early recognition, in case of an injury. Improved outcome is related to early detection and repair.

Key words: *bile duct injuries, laparoscopic cholecystectomy, cholecystectomy, diagnosis, management, prevention, interventional radiology*

RESUMO

Introdução: A maior parte dos estudos do assunto, mostram que as lesões das vias biliares ocorrem mais frequentemente durante o procedimento feito por via laparoscópica do que pela via aberta. Apesar de haver uma consciencialização deste problema, maior atenção devia ser feita para a deteção precoce e prevenção destas lesões. **Métodos:** Foi feita uma revisão da literatura Inglesa dos últimos 15 anos sobre a incidência, tratamento e prevenção de lesões biliares. Outros artigos de referência mais antigos foram também incluídos. Fontes de informação: Base de dados do PubMed e Scopus. **Resultados:** Aproximadamente 1500 artigos foram encontrados na pesquisa das palavras-chave “lesões das vias biliares” e “colecistectomia laparoscópica”. Foi feita uma seleção de um total de 68 artigos baseada no resumo, dirigida de acordo com a temática de interesse para a discussão desta revisão, e destes 49 artigos foram incluídos na bibliografia, por serem considerados de maior interesse. **Conclusões:** As lesões das vias biliares podem ser evitadas por uma identificação precisa da anatomia biliar e uma dissecação cuidadosa. O colangiograma intra-operatório diminui a sua incidência e ajuda a uma deteção precoce em caso de lesão. Um melhor prognóstico está associado a um diagnóstico e intervenção precoces.

Palavras-chave: *lesões das vias biliares, colecistectomia laparoscópica, colecistectomia, diagnóstico, tratamento, prevenção, radiologia de intervenção*



LIST OF ABBREVIATIONS

- BDI – Bile duct injuries
LC – Laparoscopic cholecystectomy
OC – Open cholecystectomy
ERCP – Endoscopic retrograde cholangiopancreatography
PTC – Percutaneous transhepatic cholangiography
MRCP – Magnetic resonance cholangiopancreatography
CVS – Critical view of safety
CBD – Common bile duct
IOC – Intra-operative cholangiography

INTRODUCTION

Since its introduction in the late 80s, laparoscopic cholecystectomy (LC) replaced rapidly open cholecystectomy (OC) as a standard treatment for symptomatic gallstone disease and acute cholecystitis.¹

The laparoscopic procedure has brought several advantages including less invasiveness, decreased length of hospital stay, less post-operative pain and a faster recover period.^{2,3}

However since its introduction the incidence of iatrogenic bile duct injuries (BDI) has increased at least double fold, changing from rates of 0.2-0.3% on OC to rates as high as 0.5-0.9% on LC.^{4,5}

Although initially these rates were thought to be an inherent process of the surgeon's learning curve for the procedure, as more experience was accumulated, these injuries were still occurring at a high frequency.⁶

Despite being relatively uncommon they are a clinical situation associated with significant morbidity affecting severely patients health and quality of life and low but not negligible mortality.⁷

Estimated costs for this complication were calculated to be around 4.5 to 26.0 times than the uncomplicated procedure, and as much as a mean cost of 108.000 euros per patient on hospital management, demonstrating a tremendous financial burden as a result of BDI.^{8,9}

In order to manage this complex disease it is required a multi-disciplinary approach including several specialists from internal medicine, surgery and interventional radiology.^{10,11}

Current issues involving BDI stand on its possible prevention with intra-operative techniques, the timing of management and referral to specialized centers when this complication does in fact occur.

CLASSIFICATION

Several methods of classification were suggested but still none is accepted as an universal standard.¹² They assist both in assessment of the injury and choice of the appropriate surgical technique for repair.

Bismuth's¹³ classification, was introduced in the time of open surgery; however, this classification does not cover the whole spectrum of injuries possible in laparoscopy since the technical factors and mechanisms that cause injury are distinct in each procedure.¹⁴

Strasberg's¹⁵ (Fig. 1 and Table 1) classification was proposed as LC became more popular, adding various other types of injuries to Bismuth's and is currently the most used and easy to understand, giving enough description and detail for the treatment modality.¹⁶ It divides in five groups where the E class is analog to Bismuth's original classification.

This classification allows dividing the etiological mechanisms of injury and using different management approaches according to the type of injury. As for example, biliary leaks which preserve bile duct continuity (Strasberg A), can be managed with a endoscopic or radiologic approach; while complex lesions that disrupt bile duct continuity (Strasberg E) demand surgical reconstruction.¹⁴

Other more recent classifications as Stewart-Way⁶ and Hannover¹⁷ have the advantage of describing other possible injuries as well as concomitant vascular injuries, but its complexity makes them less practical.²

The most recent one, ATOM proposed by European Association for Endoscopic Surgery (EAES)



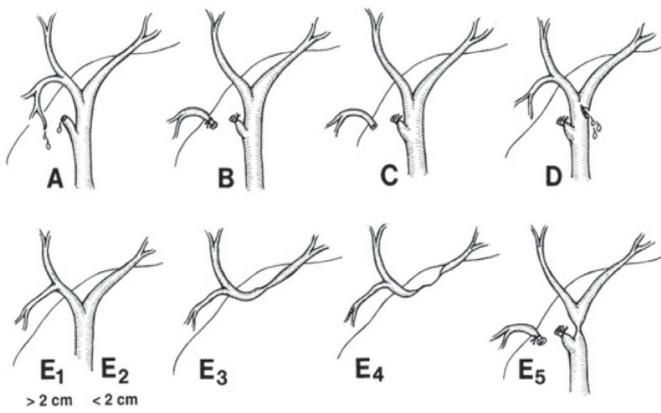


TABLE 1. Strasberg Classification of injuries

Type A	Cystic duct leaks or leaks from small ducts in the liver bed
Type B	Occlusion of part of the biliary tree, typically clipped and divided right hepatic ducts
Type C	Transection (but not ligation) of the aberrant right hepatic ducts
Type D	Lateral injuries to major bile ducts
Type E1	Common hepatic duct division, > 2cm from bifurcation
Type E2	Common hepatic duct division, < 2cm from bifurcation
Type E3	Common bile duct division at bifurcation
Type E4	Hilar stricture, involvement of confluence and loss of communication between right and left hepatic duct
Type E5	Involvement of aberrant right hepatic duct alone or with concomitant stricture of the CHD

integrates different items as the anatomical characteristics of the injury; the timing of detection, as for Intraoperative, early or late; and the mechanism of the injury. It is suggested to facilitate epidemiologic and comparative studies and to serve better therapeutic guidelines but its general acceptance and widespread use is still ongoing.¹⁸

ETIOLOGY

Several studies on large series of patients have been made to identify the main cause of iatrogenic BDI. 3, 6, 19-22

All of them pointed as the major cause a misidentification of the correct anatomy during surgery. The

primary cause was shown to be an error of visual perception and not insufficient skill of the surgeon or inadequate knowledge.⁶ Surgeon's skill has been debated as factor for increased incidence of BDI. While it seems to be true that the rates of iatrogenic injury are higher in the early portion of the surgeon's learning curve, regardless of experience, injuries still occur in a high rate.^{7, 19, 23}

The most common injury appears to result from misidentification of the common duct for the cystic duct, sometimes associated with right hepatic arterial injury.²⁴

Other mechanism described, although less common, include a "tenting injury" in which the bile duct is occluded along with the cystic duct when clipping and diathermic injuries which result of injudicious use of cautery or laser.^{4, 21} Factors contributing within the surgery have been identified as severe inflammation, poor visualization, anatomical variations (most frequently short cystic ducts), adhesions and fatty tissue on the Calot's triangle.^{3, 21}

The amount of experience of the surgeon doesn't seem to affect the incidence of bile injuries.³ A possible explanation is that currently residents learn the procedure under direct supervision of more experienced surgeons.^{6, 19}

DIAGNOSIS

An early diagnosis is crucial in preventing more serious complications and obtaining higher success repair rates.²⁵ A delay in diagnosing an injury has impact on the seriousness of the complication and is associated with a poorer outcome.²⁶

Still, over 80% of the injuries go unrecognized during surgery and patients are usually discharged within 24 hours.²

There isn't a typical presentation of symptoms for BDI. Early symptoms are usually vague and non-specific, as pain, distension, fever, nausea and vomiting. Only after a few days these symptoms reappear and other more serious complications start to develop as



jaundice, biloma, sepsis, biliary fistula and peritonitis.¹² Other less frequent presentations are recurrent cholangitis, secondary biliary cirrhosis and chronic liver disease.^{14, 26} Half of the bile duct injuries have a delayed presentation, which can only be detected in patients weeks to months later.^{25, 27} The average delay of diagnosis is 1-2 weeks, but it can be as long as several months or even few years^{28, 29}.

Investigations are based on radiological imaging and liver function biochemistry.

Increases in liver function enzymes up to 48h after surgery require evaluation of the patient, although transient non-pathologic elevations on alanine aminotransferase, bilirubin and alkaline phosphatase do occur in some percentage of healthy patients.³⁰

Abdominal ultrasonography and CT scan are performed to look for intra-abdominal fluid collections and ductal dilations.³¹ Small fluid collections are found in 10-14% of patients and are usually clinically irrelevant.³²

After identification of fluid collections (bilomas) or dilation of the bile ducts, further evaluation is necessary by accessing the biliary tract, being a cholangiography method the standard examination for evaluation of BDI.²⁵

Several techniques are available each one with their advantages: endoscopic retrograde cholangiopancreatography (ERCP), percutaneous transhepatic cholangiography (PTC) or magnetic resonance cholangiopancreatography (MRCP).

ERCP has the ability to detect the location of the bile leak and treat it simultaneously with stent placement, although it is ineffective when evaluating proximal bile duct injuries.

PTC is superior in mapping the proximal biliary ducts for information for surgical reconstruction, allowing as well stent placements and drainages but it has the highest complication rates.^{2, 28}

MRCP has shown to have equal power of diagnosis without invasiveness, plus mapping all the anatomic structures and measuring the degree of stenosis as well as detecting abdominal fluid collections and associated vascular injuries.³³

An assessment of vascular anatomy is required if a surgical procedure is to be performed. Concomitant vascular injury of the right hepatic artery was found in up to 32% of BDI and associated to an increased rate of complications.³⁴ Both computed tomography angiography or invasive angiography are suitable methods for this evaluation.

MANAGEMENT

BDI treatment can be divided in operative and non-operative. This depends on an evaluation of each case, depending on the etiological mechanism of injury.^{14, 35} Percutaneous drainage of bile collections is the first step in management to control biliary leaks.⁴

Before attempting any repair, it is essential a thorough evaluation on the patient's global condition and stabilization of the symptoms with supportive care, including intravenous fluid hydration and electrolyte replenishing for patients with significant bile leaks, antibiotic therapy for patients with infectious symptoms and analgesic administration for pain relief.³⁵

Minor injuries (small leaks and stenosis) can be treated with endoscopy or percutaneously. For this kind of injuries, sphincterotomy and stenting are the main techniques used.³⁶

Major injuries (transection, laceration and occlusion) usually require surgical reconstruction. The Roux-en-Y hepaticojejunostomy is the preferred anastomosis due to its superior results, and a complete evaluation and PTC is required to define the exact location of the injury in the proximal biliary tree.³⁵

Still, in selected patients, which develop bile duct strictures and there is biliary continuity, radiologic balloon dilation can be attempted with balloons ranging from 5 to 12mm although the success rate has proven to be low and there is an increased risk of rupture and extravasations.^{4, 35}

Partial hepatectomy can be necessary in some cases, when irreversible damaged is found in the intra-hepa-



tic biliary tree, usually occurring because of arterial injury, most commonly the right hepatic artery.^{37, 38}

The timing of the operative procedure should be individualized.¹⁶ If severe inflammation, edema or fluid collections exist at the time of diagnosis, reconstruction should be postponed²², performing only percutaneous drainage and discharge the patient for a few weeks before surgical repair allowing inflammation and adhesions to resolve.⁴

The interval for corrective surgery remains controversial but most authors advise 6 to 12 weeks following LC.^{16, 39}

BDI identified intra-operatively can be immediately repaired,⁴⁰ however studies have shown that if the repair is performed by an inexperienced surgeon, failure can be as high as 90%.^{7, 11, 16} Because of this, if no experienced surgeon is available, simple drainage and referral to a specialized center may be the best option.¹⁴

The availability of a multidisciplinary management in specialized center with experienced hepatobiliary surgeons, gastroenterologists and interventional radiologists offers the optimal treatment with the best outcome. In these settings outcome has a high rate of success.^{11, 41} Most large series from tertiary care centers report a satisfactory outcome in 80-90% of patients.⁴²

Despite that, there is a remarkable overall decrease on the quality of life of patients that undergo surgical repairs.^{43, 44}

PREVENTION

Although over 70% of surgeons perceive BDI as unavoidable, this should be regarded as a preventable injury.¹⁹ Since the main cause is a misinterpretation of the anatomy, it suggests itself as preventable. Over three quarters of injuries are not recognized at time of injury, suggesting anatomical orientation issues.²⁰ Adequate visualization and identification of the portal structures is the basis on every technique implemented to prevent BDI.^{21, 24}

Several techniques were indicated to decrease BDI in several studies.

A dissection technique, later described as critical view of safety (CVS)¹⁵ which consists in establishing correct visualization and anatomical orientation of the bile ducts – dissecting gallbladder from liver bed, clearing the triangle of Calot, ensuring correct visualization of the cystic duct, common bile duct (CBD) and cystic artery before dissection. Both junctions – gallbladder and cystic duct; common bile duct and cystic duct – should be visualized. This is achieved by dissecting the posterior biliary space, freeing the neck of the gallbladder from the liver bed and performing lateral traction of Hartman's pouch to create a sharper angle between the cystic duct and the common bile duct.^{24, 45}

Implementation of such technique has shown to decrease significantly rates of BDI.⁴⁶

Intraoperative cholangiography (IOC) has been a source of controversy in literature. The technique consists in the injection of radiographic contrast into the cystic duct through a small catheter and x-ray fluoroscopy images are obtained.^{23, 46} It allows to make correct assumptions about biliary structure, if the cannulated duct is indeed the cystic or if mistaken by the CBD, being currently the best practical aid for verifying anatomy, delineating an operative roadmap.¹²

Several studies have shown IOC's significant efficacy in preventing BDI, with significant lower rates of BDI when it is used. Fletcher¹⁰ has shown a substantial protective effect of IOC of almost 50%, particularly in high-risk cases (defined in the study as cases with associated diagnosis of pancreatitis, obstructive jaundice, cholangitis and acute cholecystitis on operative admission). Flum²³ demonstrated a 40% lower rate of injury when IOC was used, and an even lower one for inexperienced surgeons.

Also, another study from the last author suggests this technique cost-effective as routine implementation considering the costs associated with this injury.⁴⁷

Although these studies demonstrate a strong association between IOC and reduction of BDI, due to



the relative infrequency of this injury, a bigger cohort would be required to extrapolate precise conclusions.

Other advantage on this technique, it increases the likelihood of detection of injuries intra-operatively due to contrast leak contributing to an early diagnosis and a better prognosis.^{19, 48}

Other more recent techniques are being developed on this matter. A laparoscopic multi-frequency ultra-sound with doppler allows to identify the biliary anatomy with no invasiveness and no associated radiation. Success rates are comparable to IOC.⁴⁶ The drawback is that it has a longer learning curve requiring experienced surgeons to perform it.

Another recent technique, NIRF-C (Near infrared fluorescence cholangiography) using laser is a novel development but images are still not clear and the resolution is limited.⁴⁶

These are promising novel techniques but still require more evidence to evaluate their effectiveness.

CONCLUSION

Surgeons could benefit from preventive techniques to confirm the correct anatomy and avoid these unexpected injuries. There is still a lack of knowledge and information about IOC among surgeons, and many don't practice it and don't consider it an effective technique.^{3, 5, 49}

Although surgical practice is largely settled on selective instead of routinely use of IOC, it should be employed more often during LC than at present especially when difficulties are encountered in mobilizing or identifying structures or when anatomic abnormalities present.⁶ In high risk cases and among less experience surgeons, IOC has shown its highest protective power against BDI.⁴⁷

It's is also strongly advisable for surgeons on approaching a laparoscopic biliary injury, if not experienced enough, to seek an experienced biliary surgeon or if not available, to refer to an experienced reference center.^{5, 14}

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